SBIR·STTR
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National Aeronautics and Space Administration

Science Mission Directorate Overview

Presenter: Dr. Rich Terrile
Jet Propulsion Laboratory, California Institute of Technology

MD: SMD
Date: 6/26/17
TIME: 11:35PST

I N N O V A T I O N | P A R T N E R S H I P | C O M M E R C I A L I Z A T I O N

SMALL BUSINESS INNOVATION RESEARCH (SBIR) & SMALL BUSINESS TECHNOLOGY TRANSFER (STTR)

Science Mission Directorate Overview

- Science Mission Directorate (SMD)
  - One of Four NASA Mission Directorates
    - Science Mission Directorate (SMD)
    - Aeronautics Research Mission Directorate (ARMD)
    - Human Exploration and Operations Mission Directorate (HEOMD)
    - Space Technology Mission Directorate (STMD)
  - SMD is Comprised of Four Divisions
    - Astrophysics
      - Core NASA Centers: GSFC, MSFC, JPL
    - Earth Science
      - Core NASA Centers: GSFC, LaRC, JPL
    - Heliophysics
      - Core NASA Center: GSFC
    - Planetary Science
      - Core NASA Centers: JPL, GSFC

SMD BY THE NUMBERS

Spacecraft
105 missions*
88 spacecraft

CubeSats
12 science missions*
11 technology demonstrations

Balloon Payloads
13 science payloads
13 piggyback/ student payloads

Sounding Rocket Flights
14 science missions
3 technology/student missions

Earth-Based Investigations
25 major airborne missions
8 global networks

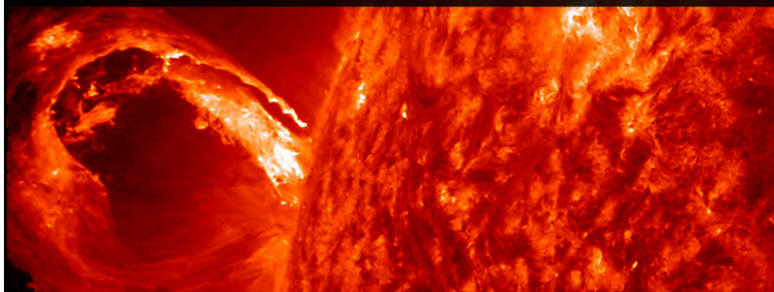
Technology Development
~$400M invested annually

Research
10,000^{+} U.S. scientists funded
3,000^{+} competitively selected awards
~$600M awarded annually

*117 space-based missions

NASA's Science Mission Directorate

Heliophysics



Make possible accurate predictions of solar phenomena throughout the solar system

Technologist: Dan Moses

Earth Science

Enable more accurate and useful environmental predictions, including weather, climate, natural and human Induced events

Technologist: Earth Science Technology Office

Planetary Science

Explore habitable environments across the solar system with human and robotic explorers

Technologist: Leonard Dudzinski

Astrophysics

Answer the question: "Are we alone?"

Technologist: William Lightsey

SMD technology tasks have science traceability to external roadmaps, reports and surveys.

Astrophysics

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"Are we alone?"

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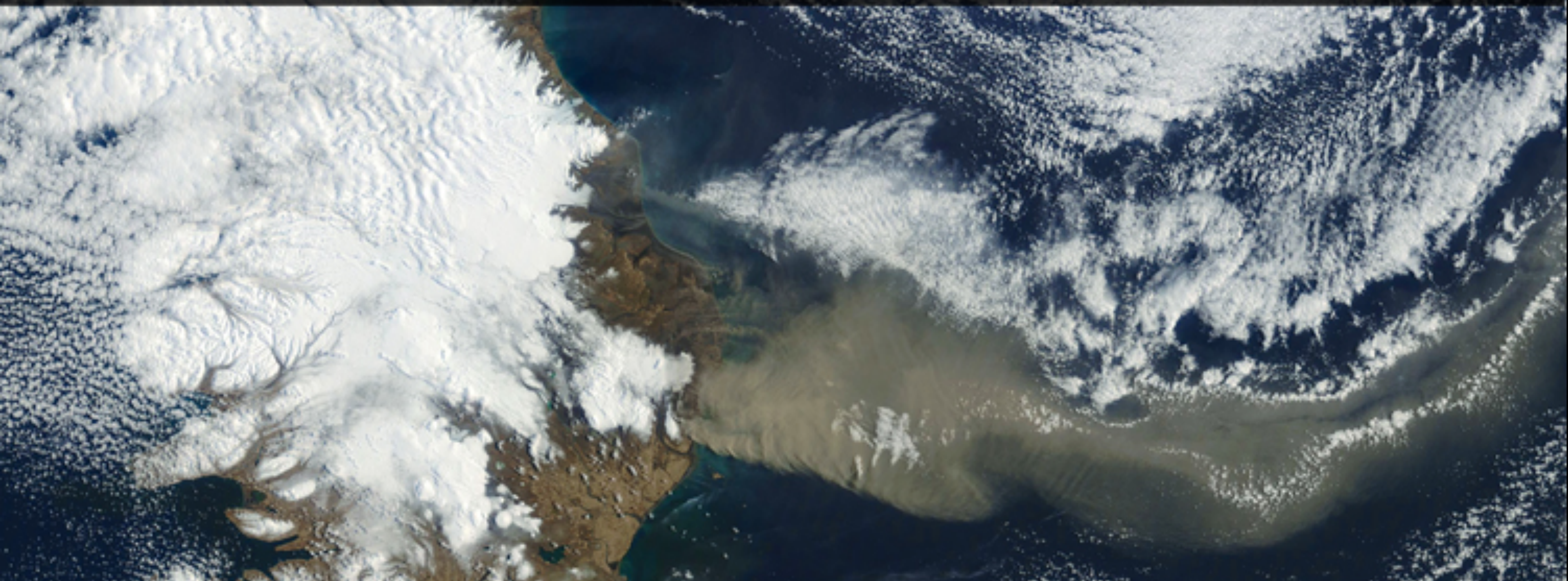
Earth Science



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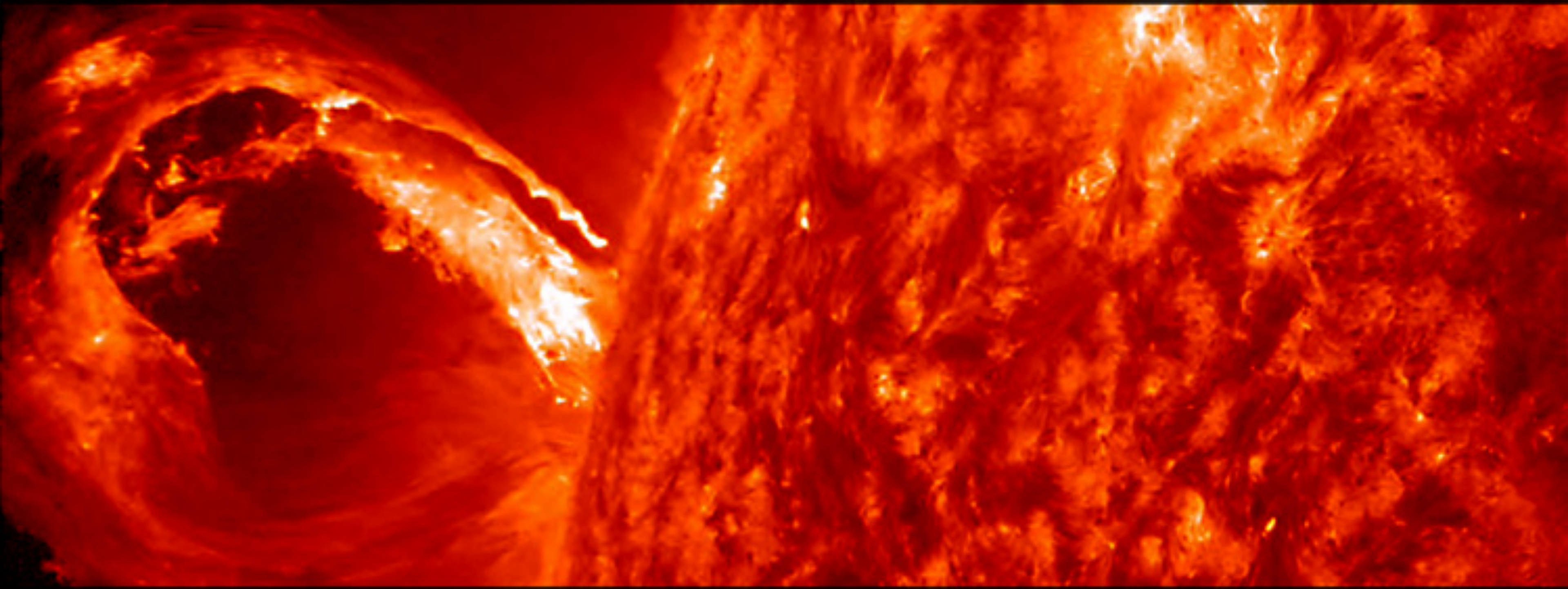

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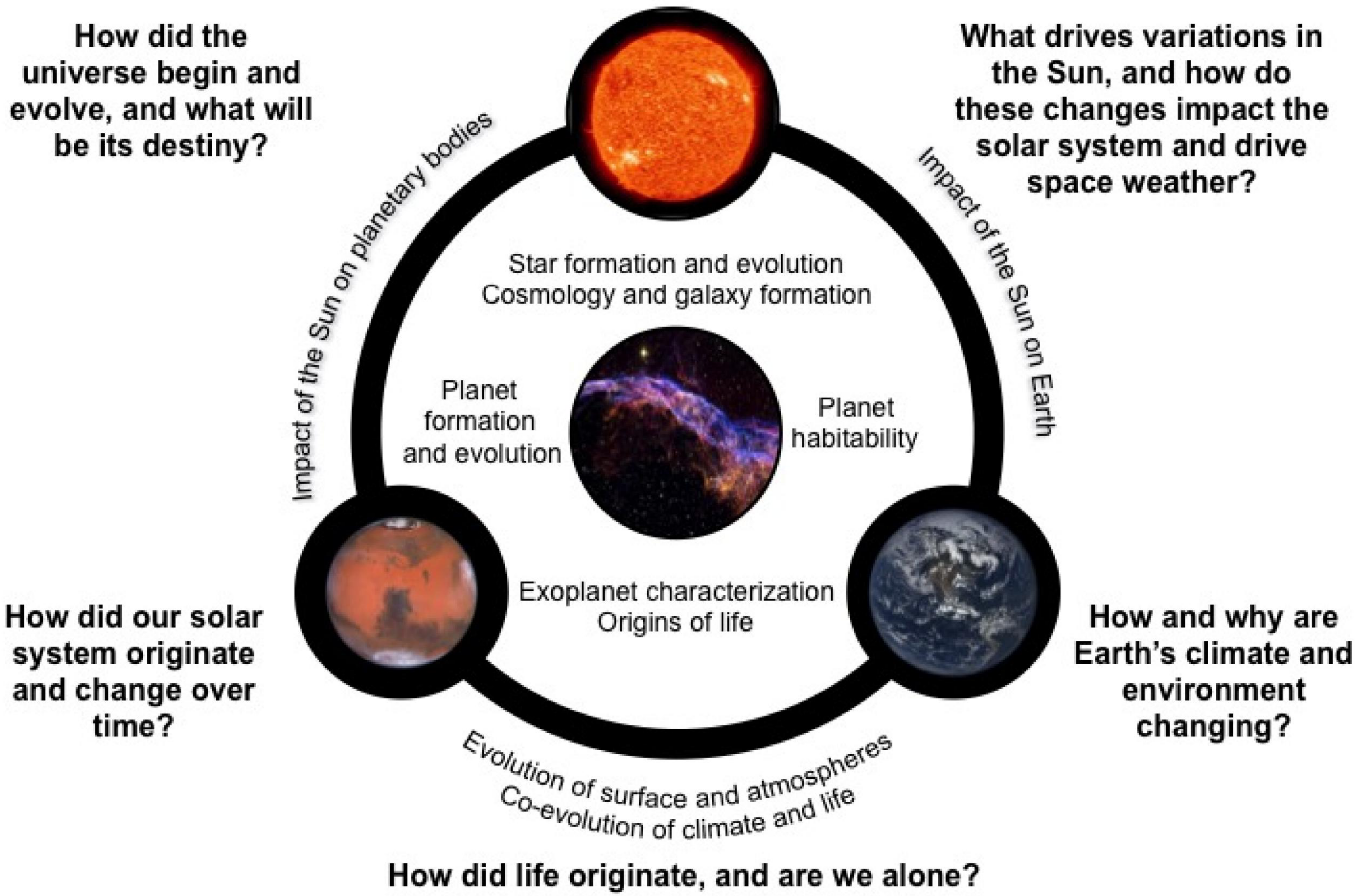
Technologist: Leonard Dudzinski

NASA Science Is Interconnected



SMD Goals and Selection Path

SMD SBIR Goal: Solicit and select the best technical efforts that can deliver what NASA projects need, that can be accomplished by small businesses with SBIR resources, and that have high center advocacy for infusion.

Solicitation Development:

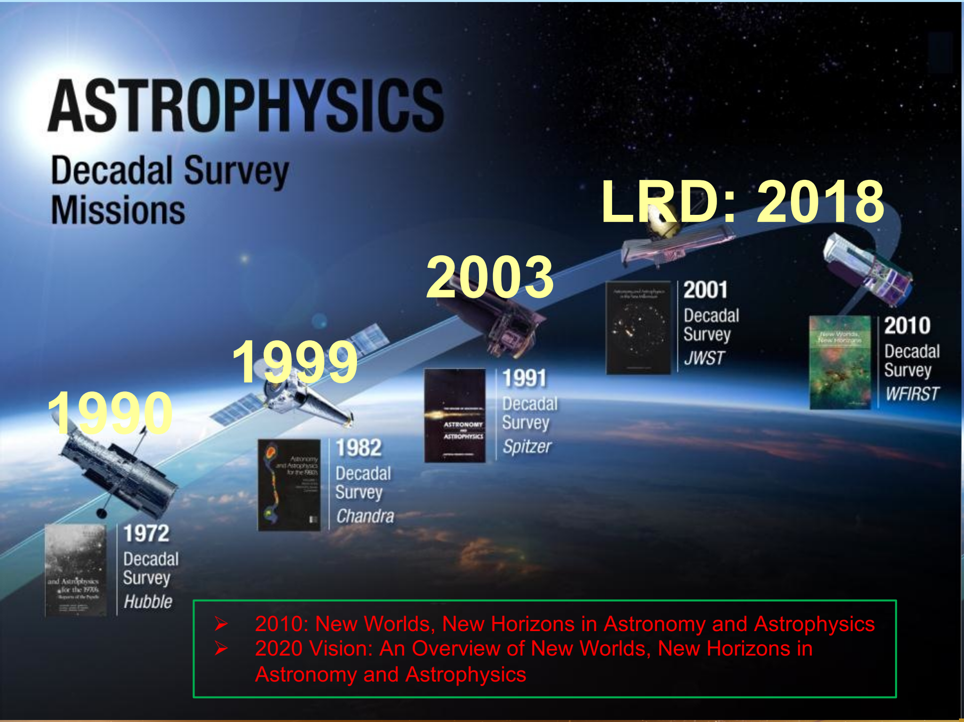
- **Create subtopics with science traceability and infusion potential**
  - Should articulate specific benefits for NASA missions and goals
  - When possible, should trace to timely science mission requirements
- **Develop tasks appropriate to small businesses**
  - No "critical path" deliverables or large, complex systems
  - End product/capability should also provide a path to an attractive return on investment for small business
  - Encourage a sustainable supply chain for technology
- **Balance the SMD Technology portfolio**
  - Solicit innovative solutions to NASA challenges
  - Select a mix of innovative ideas and technological solutions

SMD Science Traceability

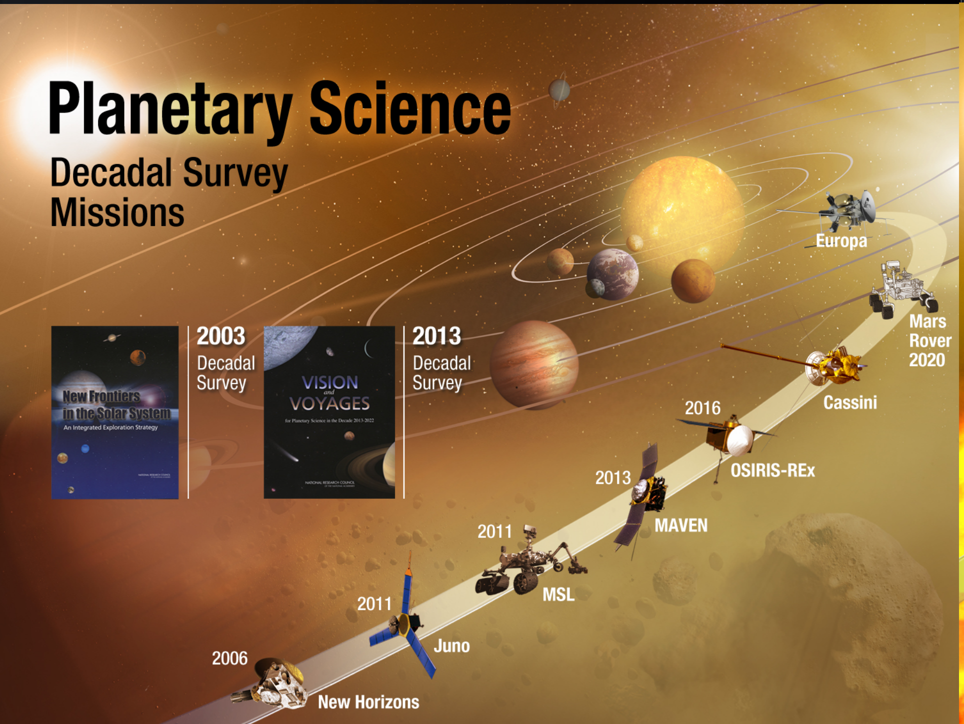
- SMD technology tasks must have science traceability to external roadmaps, reports and surveys
  - SMD has the unique benefit of science goals and measurement objectives from external committees
    - Decadal Surveys
    - NASA Advisory Committees
    - NRC Reports
  - Survey data is constantly being updated by latest results and discoveries (e.g. Direct detection of gravitational waves)

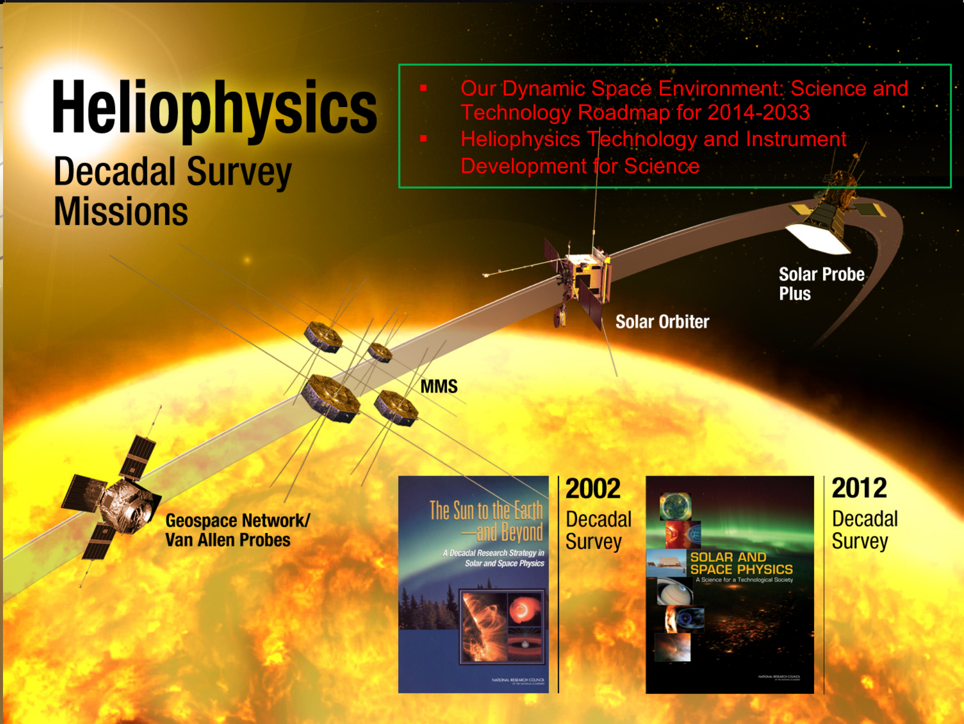
- Resources:

https://science.nasa.gov/about-us/science-strategy


ASTROPHYSICS
Decadal Survey
Missions
LRD: 2018
2003
1999
1990
1972
Decadal
Survey
Hubble
1982
Decadal
Survey
Chandra
1991
Decadal
Survey
Spitzer
2001
Decadal
Survey
JWST
2010
Decadal
Survey
WFIRST
➢ 2010: New Worlds, New Horizons in Astronomy and Astrophysics
➢ 2020 Vision: An Overview of New Worlds, New Horizons in Astronomy and Astrophysics


Earth Science
Climate Architecture
Missions
OSTM/Jason 2
Aquarius
Suomi-NPP
Landsat-8
GPM
OCO-2
SMAP
SAGE III
CYGNSS
ICESat-2
GRACE-FO
SWOT
PACE
NI-SAR
EARTH SCIENCE AND APPLICATIONS FROM SPACE
2007
Decadal
Survey
2010
Climate
Architecture


Planetary Science
Decadal Survey
Missions
New Frontiers in the Solar System
2003
Decadal
Survey
VISION and VOYAGES
2013
Decadal
Survey
Europa
Mars
Rover
2020
Cassini
2016
OSIRIS-REx
2013
MAVEN
2011
MSL
2011
Juno
2006
New Horizons


Heliophysics
Decadal Survey
Missions
▪ Our Dynamic Space Environment: Science and Technology Roadmap for 2014-2033
▪ Heliophysics Technology and Instrument Development for Science
Solar Probe
Plus
Solar Orbiter
MMS
Geospace Network/
Van Allen Probes
The Sun to the Earth —and Beyond
2002
Decadal
Survey
SOLAR AND SPACE PHYSICS
2012
Decadal
Survey

JPL SBIR in Space – Curiosity

Grammatech - Software for eliminating defects in mission-critical and embedded software applications directing rover operations

Starsys Research - Planetary gearboxes for the articulated robotic arm and the descent braking mechanism for controlling rate of descent to planetary surface

Creare - A space-qualified vacuum pump for the Sample Analysis at Mars (SAM) instrument package

ABOUT THE MISSION

The Mars Science Laboratory mission's Curiosity rover, the most technologically advanced rover ever built, landed in Mars' Gale Crater the evening of Aug. 5, 2012 PDT (morning of Aug. 6 EDT) using a series of complicated landing maneuvers never before attempted. The specialized landing sequence, which employed a giant parachute, a jet-controlled descent vehicle and a bungee-like apparatus called a "sky crane," was devised because tested landing techniques used during previous rover missions could not safely accommodate the much larger and heavier rover.

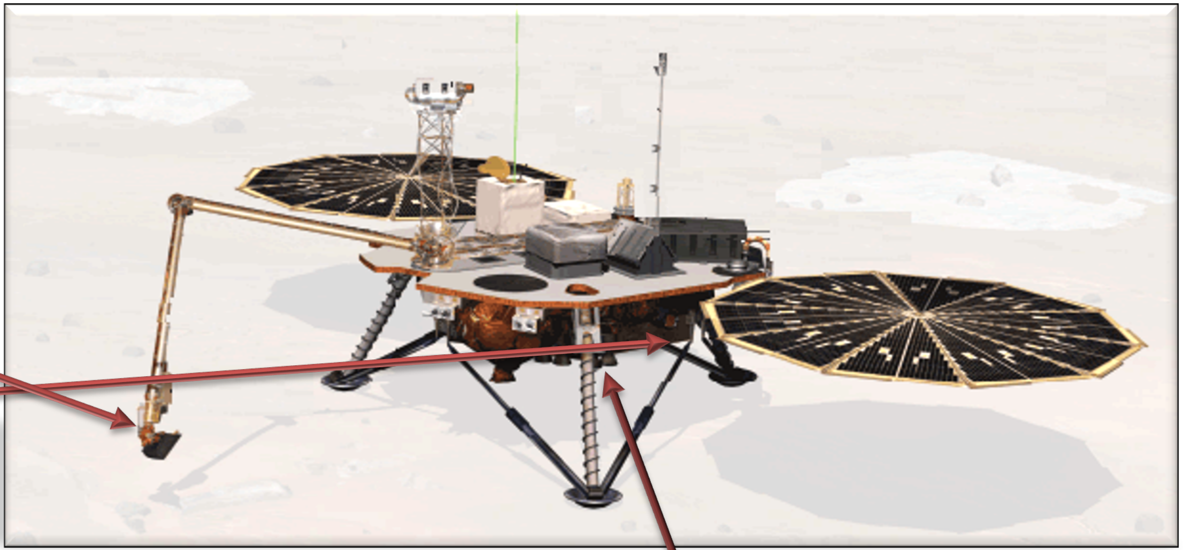
Curiosity's mission is to determine whether the Red Planet ever was, or is, habitable to microbial life. The rover, which is about the size of a MINI Cooper, is equipped with 17 cameras and a robotic arm containing a suite of specialized laboratory-like tools and instruments.

Yardney Technical Products – Lithium ion batteries that enable the power system to meet peak power demands or rover activities

Honeybee Robotics – Dust removal tool used to remove the dust layer from rock surfaces and to clean the rover's observation tray and designed the sample manipulation system for the Sample Analysis at Mars (SAM) instrument package

inXitu– Features of their automated sample handling system are implemented in the Chemistry and Mineralogy experiment (CheMin) instrument

JPL SBIR in Space – Phoenix Mission



Icy Soil Acquisition Device supplied by **Honeybee Robotics, Inc.**

SpaceDev contributed wet chemistry elements of the Microscopy Electrochemistry and Conductivity Analyzer (MECA)

Lithium ion batteries supplied by **Yardney Technical Products, Inc.**

ABOUT THE MISSION

Phoenix was a lander sent to the surface of Mars to search for evidence of past or present microbial life. Using a robotic arm, it could dig up to half a meter into the Red Planet to collect samples and return them to onboard instruments for analysis. Besides verifying the existence of water-ice in the Martian subsurface, Phoenix discovered traces of the chemical perchlorate, a possible energy source for microbes and a potentially valuable future resource for human explorers.

As planned, the Phoenix lander ended communications in November 2008, about six months after landing, when its solar panels ceased operating in the dark Martian winter.

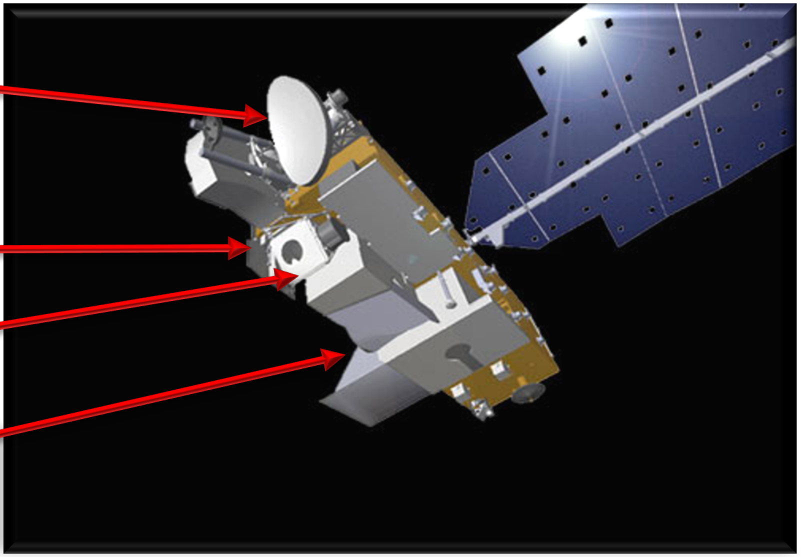
JPL SBIR in Space – Aura Mission

Composite Optics provided light weight, large aperture reflector of graphite reinforced composite material with high surface accuracy for the Microwave Limb Sounder (MLS)

DeMaria Electrooptics Under a $6.5 million contract with JPL, the company provided a terahertz radiometer for the MLS

Spaceborne supplied two correlator chips that make the analog to digital signal conversion and clean up the signal received by MLS

Lightwave Electronics provided two diode pumped solid state lasers for Tropospheric Emission Spectrometer (TES)



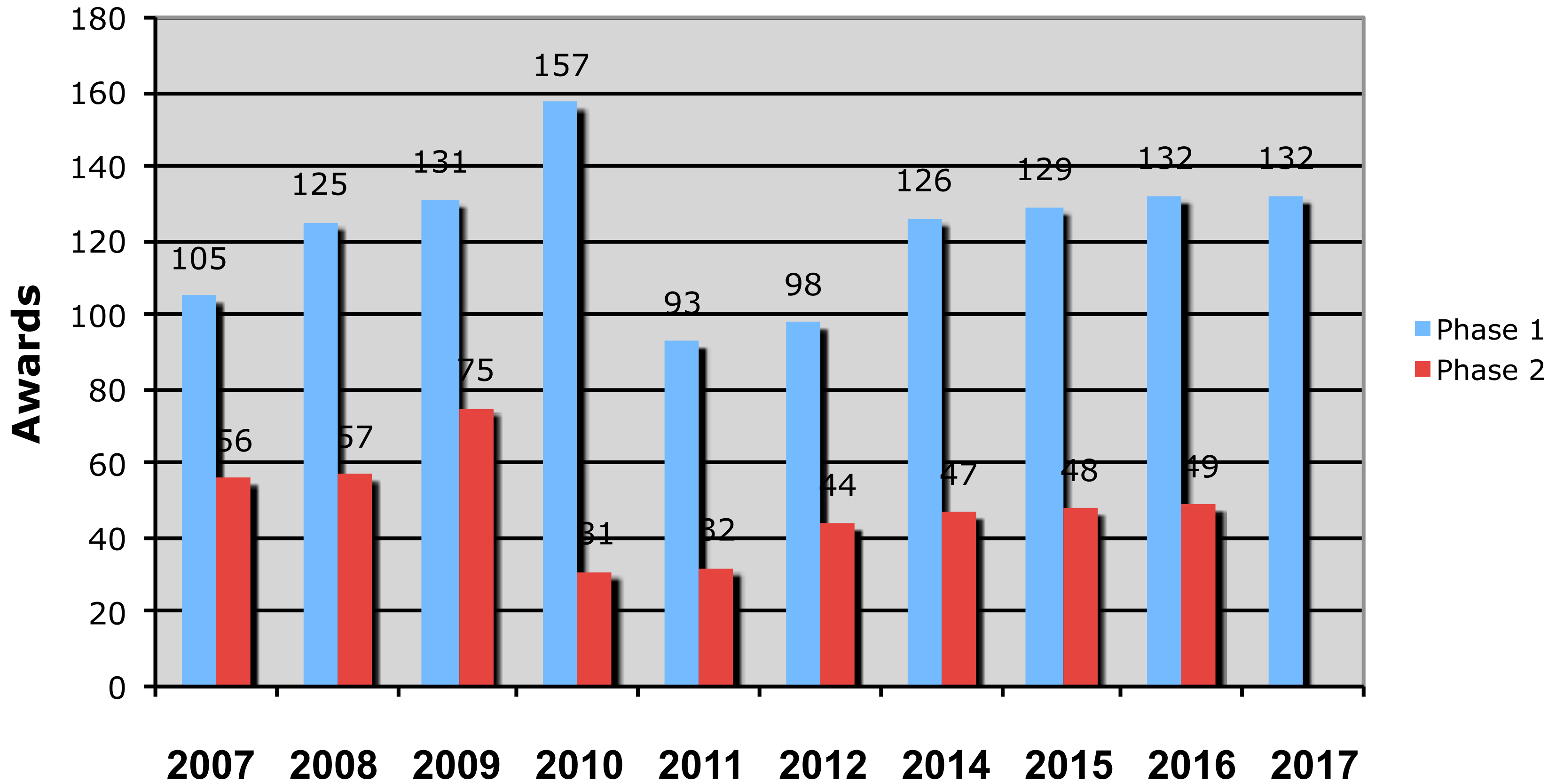
ABOUT THE MISSION

Aura (formerly EOS/Chem-1) is the chemistry mission of NASA with the overall objective to study the chemistry and dynamics of Earth's atmosphere from the ground through the mesosphere. The mission monitors the complex interactions of atmospheric constituents from both natural and man-made sources, such as biomass burning that effect the creation and depletion of ozone. The Aura mission provides global surveys of several atmospheric constituents which can be classified into anthropogenic sources (CFC types), radicals (e.g., ClO, NO, OH), reservoirs (e.g., HNO, HCl), and tracers (e.g., N2O, CO2, H2O). Temperature, geopotential heights, and aerosol fields will also be mapped.

Seaspace Corporation
Developed low cost system that makes it possible for universities and other purchasers to receive the data transmissions from Aura

SMD SBIR Award History

Subtopics	39	34	43	39	36	29(3)	32(3)	35(2)	32	35	Total (Select)
P1 Ratio	23.8%	27.1%	23.6%	28.6%	17.6%	20.0%	27.9%	25.3%	27.0%	27.7%	
P2 Ratio	53.3%	44.9%	57.3%	19.7%	34.4%	44.9%	37.3%	37.2%	37.1%		



2017 SMD SBIR Subtopics

TOPIC S1 Sensors, Detectors, and Instruments

- **S1.01** Lidar Remote Sensing Technologies
- **S1.02** Technologies for Active Microwave Remote Sensing
- **S1.03** Technologies for Passive Microwave Remote Sensing
- **S1.04** Sensor and Detector Technology for Visible, IR, Far IR and Submillimeter
- **S1.05** Detector Technologies for UV, X-Ray, Gamma-Ray and Cosmic-Ray Instruments
- **S1.06** Particles and Field Sensors and Instrument Enabling Technologies
- **S1.07** In Situ Sensors Instruments/Technologies for Planetary Science
- **S1.08** Surface & Sub-surface Measurement Systems
- **S1.09** Cryogenic Systems for Sensors and Detectors
- **S1.10** Atomic Interferometry
- **S1.11** In Situ Instruments/Technologies for Ocean Worlds Life Detection
- **S1.12** Sample Processing for Life Detection Investigations for Ocean Worlds

TOPIC S2 Advanced Telescope Systems

- **S2.01** Proximity Glare Suppression for Astronomical Coronagraphy
- **S2.02** Precision Deployable Optical Structures and Metrology
- **S2.03** Advanced Optical Systems and Fabrication/Testing/Control Technologies for EUV/Optical and IR Telescope
- **S2.04** X-Ray Mirror Systems Technology, Coating Technology for X-Ray-UV-OIR, and Free-Form Optics

TOPIC S3 Spacecraft and Platform Subsystems

- **S3.01** Power Generation and Conversion
- **S3.02** Propulsion Systems for Robotic Science Missions
- **S3.03** Power Electronics and Management, and Energy Storage
- **S3.04** Guidance, Navigation and Control
- **S3.05** Terrestrial and Planetary Balloons
- **S3.06** Thermal Control Systems
- **S3.07** Slow and Fast Light
- **S3.08** Command, Data Handling and Electronics

TOPIC S4 Robotic Exploration Technologies

- **S4.01** Planetary Entry, Descent and Landing and Small Body Proximity Operation Technology
- **S4.02** Robotic Mobility, Manipulation and Sampling
- **S4.03** Spacecraft Technology for Sample Return Missions
- **S4.04** Extreme Environments Technology
- **S4.05** Contamination Control and Planetary Protection
- **S4.06** Sample Collection for Life Detection in Outer Solar System Ocean World Plumes

TOPIC S5 Information Technologies

- **S5.01** Technologies for Large-Scale Numerical Simulation
- **S5.02** Earth Science Applied Research and Decision Support
- **S5.03** Enabling NASA Science Through Large-Scale Data Processing and Analysis
- **S5.04** Integrated Science Mission Modeling

Potential New SMD Subtopics

- Life Detection in Ocean Worlds
  - Sample collection
  - Sample concentration
  - Life detection
- Integrated Systems on a Chip
- Cube Sat and Small Sat Science Instruments
- Information Technology and Cybersecurity
- Etc.

Parts versus Ideas

- Parts
  - Highly specified
  - Specify requirements
  - Solves a specific application
  - Higher TRL
  - Readily commercialized
  - Lower perceived risk
  - No surprises
- Ideas
  - Not well specified
  - Specify goals
  - Potential for enabling new applications
  - Lower TRL
  - Higher perceived risk
  - Higher potential ROI
  - Surprises

- Encourage innovative alternatives to address challenges with subtopics
  - Solicit “ideas” as well as “parts”
  - Creates flexibility for creative approaches to technical challenges

Phase I Evaluation Criteria

- Evaluation Criteria
  - NASA intends to select for award those proposals that offer the most advantageous research and development to stimulate technical innovation to the Government and the SBIR/STTR Program. NASA will give primary consideration to the scientific and technical merit and feasibility of the proposal and its benefit to NASA interests. Each proposal will be evaluated and scored on its own merits using the factors described below:
    1. Scientific/Technical Merit and Feasibility
    2. Experience, Qualifications and Facilities
    3. Effectiveness of the Proposed Work Plan
    4. Commercial Potential and Feasibility
    5. Price Reasonableness

Benefit to NASA Interests

- NASA Interests Determined By:
  - Science Goals
  - Mission Requirements
  - NASA Programs
- What can change NASA Interests
  - New Discoveries
    - Observatories
    - Lab results
    - Mission results
  - New, Canceled or Delayed Missions
  - Politics – Mandated changes in national priorities

Proposal Tips

- Review prior years solicitations at http://sbir.nasa.gov/
- Search and identify specific technical areas (subtopics) and lead center(s) of your interest
- Request subject matter expert contact information from respective field center program POCs
- E-mail/Call technical POCs and initiate dialogues
- Learn technology needs, priorities, and funding gaps
- Visit and brief NASA on your companies capabilities, if the opportunity presents itself (Industry Day)
- **<u>Please note</u>** – once a solicitation is active, NASA centers, including JPL are not permitted to discuss the active solicitation

Proposal Advice

- The proposal process begins right now, not after the solicitation is released.
- Writing a winning a proposal is a long term process that involves:
  - Understanding the needs of NASA
  - Interacting with the technical community
    - Help us write our subtopic descriptions by letting us know what you are capable of providing.
    - Find out how you can best be a benefit to NASA science and technical needs.
- Read the solicitation carefully.
  - Do not assume it is the same as last year.
  - Reread it again, your competition did.
- Provide all of the required information, including Part 7 – Commercialization for Phase II proposals.
- Explain (early and concisely) how your effort will benefit NASA interests.
- You never finish writing a proposal, you just run out of time.

The End

THANK YOU FOR YOUR PARTICIPATION!

NOTE: *This presentation will be accessible through the Industry Day website.*